8. Water Balance

This Section develops a water balance for the City of Hollister's LTWMP. The water balance is used to estimate the size of the seasonal storage reservoir that the City will need to construct to hold treated effluent produced by the DWTP during the wet winter months. The water balance also assists the City in identifying the number of acres of land that the City will have to acquire and use as spray fields for disposal of effluent during the dry summer months.

8.1. Background

It is the City's goal to maximize the reuse of treated effluent in the region. As discussed in **Section 7**, the City, the SBCWD and the County evaluated a wide range of effluent disposal options for the DWTP and recommended the development of spray fields for interim effluent disposal until such time as the City's Recycled Water Project (discussed in **Section 9**) could be more fully implemented to maximize the reuse of recycled water. Ultimately, the City would like to dispose of 100% of its effluent through irrigation reuse. Updating the City's Waste Discharge Requirements (WDR) permit through the RWQCB to permit the disposal of the effluent on spray fields (as well as recycled water irrigation fields) will require the City not to apply water at rates that exceed the agronomic demands of the irrigated vegetation.

The uptake of water by plants occurs through the evapotranspiration process. Evapotranspiration is the process whereby plants lose water through the combined processes of evaporation to the atmosphere and transpiration. Transpiration is the process of water loss from plants through stomata. Stomata are small openings found on the underside of leaves that are connected to vascular plant tissues. Transpiration is a passive process largely controlled by the humidity of the atmospheric and the moisture content of the soil. Of the transpired water passing through a plant typically only about 1 % is used in the growth process. Transpiration transports nutrients from the soil into the roots and carries them to the various cells of the plant. Evapotranspiration is limited to the growing season and the uptake of irrigation water by plants is further limited to those periods of time when there is insufficient soil moisture available to meet the water demands of the plants.

In addition, the RWQCB will generally not allow the application of recycled water to spray fields when saturated soil conditions exist that would result in potential co-mingling of treated effluent with rain run-off. Therefore, because of local meteorological conditions, plant physiology, and RWQCB permitting constraints, the disposal of effluent on spray fields can be assumed to be limited to the warmer and drier months in Northern California. Generally, these months run from about April until about October.

Because the City will only be able to dispose of its effluent on spray fields during the dry months, it must construct a seasonal storage reservoir to store its effluent during the wet season when it cannot dispose of water. The City must then construct sufficient spray fields to not only dispose of the effluent that it generates during the dry months, but it must also construct sufficient spray fields to also dispose of all of the water that has accumulated in its seasonal storage reservoir during the wet months. The ultimate operational strategy would therefore be to ensure that the City's storage reservoir is sufficiently empty at the end of the irrigation season to have sufficient storage capacity to store all of the effluent that will be generated by the City during the upcoming wet season. Operation of the spray fields and the storage reservoir therefore becomes essentially a balancing act between storing water during the wet season and disposing of water during the dry season. In order for the City to plan for the design of these storage and spray field facilities the City must first develop and understand this water balance under build-out conditions.

8.2. Water Balance

Water balance analyses were performed to determine the amount of seasonal storage required for the two phases of the LTWMP. The water balance assumes there will be between 0.5 – 2.0 MGD of disposal in the existing percolation beds located at the DWTP and management of the remainder of effluent by landscape or spray field irrigation. No expansion of the City's percolation beds is proposed. In Phase I (Interim Effluent Management Project through 2013) it is assumed that the City will dispose of the vast majority of its effluent by spray field irrigation of pasture grass. In Phase II (Recycled Water Project through 2023) it is assumed that the City has implemented its recycled water program and all of the City's effluent is disposed of through recycled water irrigation.

Water balances were prepared for the City's Phase I Interim Effluent Management Project (2013) and the City's Phase II Recycled Water Project (2023). The Phase I Interim Effluent Management Project will manage and dispose of the City's effluent on spray fields for approximately the first 5 years (from 2008 until 2013). This is an interim project until the City can more fully develop and implement its recycled water project. By 2023 the City will implement its Phase II Recycled Water Project that is anticipated to be a regional recycled water program.

8.2.1. Precipitation

The amount of precipitation influences the amount of water that the City will be able to dispose of on spray fields. In addition, rainfall will fall into the City's open seasonal storage reservoir and must be accounted for in the water balance. Monthly precipitation distributions for the Hollister project area were analyzed for four scenarios for the purpose of preparing the LTWMP water balances. The four rainfall scenarios evaluated were for a typical year, the 25-year return period rainfall year, the 50-year return period rainfall year, and the 100-year return period. Monthly rainfall distributions were calculated for each scenario. For the purposes of these statistical evaluations, monthly rainfall data from 1875 through 2004 was analyzed. Rainfall values prior to June 1995 were taken from the City of Hollister rain gage while data after 1995 was collected at the California Irrigation Management Information System (CIMIS) station at the SBCWD offices. The results of these precipitation probability analyses are summarized in **Table 8-1**. The most conservative data for the 100-Year Return Period were used in the LTWMP water balances.

8.2.2. Percolation

The City currently percolates treated effluent into the groundwater in 8 percolation beds at the DWTP on the east side of Highway 156 and 7 beds on the west side of the highway. Percolation rates vary significantly over the course of the year with significantly reduced percolation rates observed during the wet season when soil conditions are saturated and groundwater levels are high. **Table 8-2** summarizes combined monthly percolation rates observed by City staff for all of the percolation beds at the DWTP from 2000 through 2004. Percolation rates observed by City staff in each individual percolation bed suggests that approximately 60% of the City's combined percolation capacity occurs in the western percolation beds. Because the City will not be able to utilize the western percolation beds after construction of a seasonal storage reservoir on the west side of the DWTP, it is assumed that only 40% of the City's current percolation capacity will be available for long-term continued disposal of treated effluent.

Table 8-1: Hollister Project Area Precipitation (inches)[a]

Month	Typical Year	25-Year Return	50-Year Return	100-Year Return
January	5.68	4.01	4.39	4.70
February	0.12	3.26	3.60	3.81
March	0.54	3.16	3.20	3.37
April	0.14	1.75	1.92	1.98
May	0.17	0.88	1.04	1.18
June	0.06	0.28	0.30	0.34
July	0.84	0.16	0.22	0.46
August	0.56	0.11	0.19	0.46
September	0.06	0.66	1.13	1.80
October	0.81	1.13	1.20	1.44
November	3.14	2.73	2.68	2.86
December	4.51	3.34	3.50	3.73
TOTAL	**16.63**	**21.46**	**23.35**	**26.12**

[a]The information in this table was obtained from the Technical Memorandum (RMC, 2005).

Table 8-2: Combined Historical Percolation Rates at the Hollister DWTP

Month	Year (MGD)					Minimum Percolation Rate	Average Percolation Rate
	2000	2001	2002	2003	2004		
January	2.01	1.56	1.22	1.03	1.32	1.03	1.43
February	1.79	0.78	1.81	1.47	1.72	0.78	1.51
March	1.76	0.79	1.22	1.72	1.16	0.79	1.33
April	2.29	2.53	1.49	1.50	1.33	1.33	1.83
May	2.30	2.14	2.87	2.88	2.44	2.14	2.53
June	1.87	2.33	2.39	3.01	3.29	1.87	2.58
July	2.27	2.56	2.77	2.43	2.34	2.27	2.47
August	2.66	2.19	2.72	2.87	2.69	2.19	2.63
September	2.47	1.83	2.56	2.59	2.53	1.83	2.40
October	2.05	1.56	1.88	2.04	2.16	1.61	1.94
November	1.91	1.61	1.65	1.90	1.70	1.61	1.75
December	1.27	1.01	2.30	1.49	1.65	1.01	1.54

Because the percolation rates presented in **Table 8-2** represent actual volumes of water percolated (and not percolation capacity), they are considered somewhat conservative. For the purposes of the LTWMP water balance, it was assumed that the City will be able to continue to percolate at least 40% of their historical <u>average</u> percolation rates at the DWTP.

8.2.3. Irrigation Demands

Crop irrigation demands will be the primary method of disposing of treated effluent from the DWTP. As discussed above, the City will not be able to apply treated effluent for irrigation purposes at any rate that exceeds the agronomic uptake rate. This agronomic uptake rate is a function of the type of crop being irrigated, the time of the growing season, and the amount of precipitation. As a result, the amount of land that will need to be irrigated to meet the disposal requirements of the City will also be dependent upon these same factors. **Table 8-3** summarizes net monthly water demands for turf grass, pasture grass, and vegetables during a 100-year rainfall year. In the water balance for the interim project (2013) it is assumed that all of the disposal will be on spray fields as discussed in **Section 7**. Pasture grass has a relatively high water demand of 41.2 inches in a 100-year rainfall year.

Table 8-3: Net Crop Water Demands[a]

Month	100-Year Rainfall Year Water Demands (inches) Turf Grass	Pasture Grass	Vegetables
January	0.0	0.0	0.0
February	0.0	0.0	0.0
March	0.0	0.0	1.4
April	2.5	3.1	4.3
May	4.7	5.9	1.8
June	5.7	8.3	0.1
July	6.2	8.9	1.0
August	5.7	8.2	2.0
September	2.3	4.2	0.6
October	1.2	2.6	1.2
November	0.0	0.0	0.0
December	0.0	0.0	0.0
TOTAL	**28.3**	**41.2**	**12.4**

[a]The information in this table was obtained from the Technical Memorandum (RMC, 2005).

Because the City's goal is to ultimately maximize the reuse of recycled water for irrigation, it cannot be assumed that all of the water will always be used for irrigation of pasture grass. It is anticipated that the City will ultimately use this water to also irrigate some combination of turf grass, vegetables, trees, and other vegetation. For the purposes of the water balance, it was assumed that crop water demands for the City's ultimate project would be roughly equivalent to the water demands of irrigated turf (28.3 inches).

8.2.4. Seasonal Storage Reservoir Size

Water balances were prepared for the interim Recycled Water Project-Phase I (2013) and the Recycled Water Project-Phase II (2023). The results of the water balances are summarized in **Table 8-4**. **Table 8-4** suggests that by 2013 the City's LTWMP will require approximately 1,500 AF of annual seasonal storage. In order for the City to draw this reservoir down before the beginning of each wet season, it is estimated that the City will need at least 875 acres of spray fields assuming 100-Year rainfall water demands for pasture grass as presented in **Table 8-3** above. **Table 8-4** further suggests that the City's seasonal storage requirements will increase to approximately 2,000 AF by the year 2023. The amount of irrigated acreage that will be required for the City to dispose of all of its annual effluent production will be dependent upon the type crop irrigated. Assuming 100-Year rainfall water demands for irrigated turf as presented in **Table 8-3**, it is estimated that the City will require at least 1,775 acres of turf (or comparable crop) by the year 2023. These numbers are preliminary and are for planning purposes.

Table 8-4: Summary of LTWMP Water Balance

Planning Criteria	Phase I 2008 through 2013	Phase II 2013 through 2023
Seasonal Storage Reservoir (AF)	1,500	2,000
Irrigated Acreage (Acres)	875[a]	1,775[b]

[a]Assumes irrigation of pasture grass with a 100-Year annual irrigation demand of 41.2 inches.
[b]Assumes irrigation of Row Crops or Turf grass with a 100-Year annual irrigation demand of 28.3 inches.

Table 8-5 presents the details and assumptions used in the water balance for the Recycled Water Project-Phase I. **Table 8-6** presents an updated water balance for the Recycled Water Project-Phase II for the year 2023. The flows and planning horizon for **Table 8-6** are consistent with the City's current draft General Plan.

Table 8-5: Water Balance for City of Hollister LTWMP Phase I Interim Effluent Management Project (2008-2013)

Month	Average Daily Flow (MGD)[a]	Monthly Wastewater Flow (MG)[b]	Monthly Wastewater Flow (AF)[b]	Monthly Precipitation (AF)[c]	Monthly Percolation (AF)[d]	Monthly Evaporation (AF)[e]	Irrigation Demands (AF)[f]	Surplus Water (AF)[g]	Cumulative Storage (AF)[h]
January	3.58	111	341	29.0	-54.2	-8.8	0.0	307	911
February	3.58	100	308	23.5	-52.4	-12.0	0.0	267	1,177
March	3.58	111	341	20.8	-50.4	-16.2	0.0	295	1,472
April	3.58	107	330	12.2	-67.2	-19.4	-226.0	29	1,501
May	3.50	108	333	7.3	-96.1	-26.9	-430.2	-213	1,288
June	3.41	102	314	2.1	-94.8	-33.3	-605.2	-417	871
July	3.41	105	324	2.8	-94.2	-37.5	-649.0	-453	417
August	3.41	105	324	2.8	-99.9	-34.3	-597.9	-405	12
September	3.41	102	314	11.1	-88.4	-26.9	-306.3	-96	0
October	3.41	105	324	8.9	-74.2	-21.3	-189.6	48	48
November	3.50	104	322	17.7	-64.5	-14.4	0.0	261	309
December	3.58	111	341	23.0	-59.0	-9.7	0.0	295	604

[a]Average Daily Flow (ADF) for the year 2013 (See Table 4-2). Assumes ADF equals ADWF from June until October and assumes 5% average I/I from December until April.
[b]ADF is totaled for each month.
[c]Monthly precipitation calculated for 100-Year Precipitation Return Event (See Table 8-1).
[d]Monthly percolation rates calculated assuming 40% percolation of average DWTP percolation from 2000 through 2004 (See Table 8-2).
[e]75% of mean monthly pan evaporation data for Hollister from 1962 through 1966 (Ref: DWR, Evaporation from Water Surfaces in California, Bulletin 73-79, November 1979).
[f]Irrigation demands are assumed for irrigated pasture in a 100-Year Rainfall Year (See Table 8-3).
[g]Surplus water is calculated as the net amount of water for each month that cannot be disposed of on spray fields and must added to the seasonal storage reservoir.
[h]Cumulative storage is the accumulated amount of water for which the City must provide seasonal storage.

Table 8-6: Water Balance for City of Hollister LTWMP Phase II Recycled Water Project (2013-2023)

Month	Average Daily Flow (MGD)[a]	Monthly Wastewater Flow (MG)[b]	Monthly Wastewater Flow (AF)[b]	Monthly Precipitation (AF)[c]	Monthly Percolation (AF)[d]	Monthly Evaporation (AF)[e]	Irrigation Demands (AF)[f]	Surplus Water (AF)[g]	Cumulative Storage (AF)[h]
January	4.73	146	450	29.0	-54.2	-8.8	0.0	416	1,347
February	4.73	132	406	23.5	-52.4	-12.0	0.0	365	1,712
March	4.73	146	450	20.8	-50.4	-16.2	0.0	404	2,116
April	4.73	141	435	12.2	-67.2	-19.4	-369.8	-9	2,107
May	4.61	142	439	7.3	-96.1	-26.9	-695.2	-372	1,735
June	4.5	135	414	2.1	-94.8	-33.3	-843.1	-555	1,180
July	4.5	139	428	2.8	-94.2	-37.5	-917.1	-618	562
August	4.5	139	428	2.8	-99.9	-34.3	-843.1	-546	16
September	4.5	135	414	11.1	-88.4	-26.9	-340.2	-30	0
October	4.5	139	428	8.9	-74.2	-21.3	-177.5	164	164
November	4.61	138	425	17.7	-64.5	-14.4	0.0	364	528
December	4.73	146	450	23.0	-59.0	-9.7	0.0	404	931

[a]Average Daily Flow (ADF) for the year 2013 (See Table 4-2). Assumes ADF equals ADWF from June until October and assumes 5% average I/I from December until April.
[b]ADF is totaled for each month.
[c]Monthly precipitation calculated for 100-Year Precipitation Return Event (See Table 8-1).
[d]Monthly percolation rates calculated assuming 40% percolation of average DWTP percolation from 2000 through 2004 (See Table 8-2).
[e]75% of mean monthly pan evaporation data for Hollister from 1962 through 1966 (Ref: DWR, Evaporation from Water Surfaces in California, Bulletin 73-79, November 1979).
[f]Irrigation demands are assumed for irrigated turf in a 100-Year Rainfall Year (See Table 8-3).
[g]Surplus water is calculated as the net amount of water for each month that cannot be disposed of on spray fields and must added to the seasonal storage reservoir.
[h]Cumulative storage is the accumulated amount of water for which the City must provide seasonal storage.